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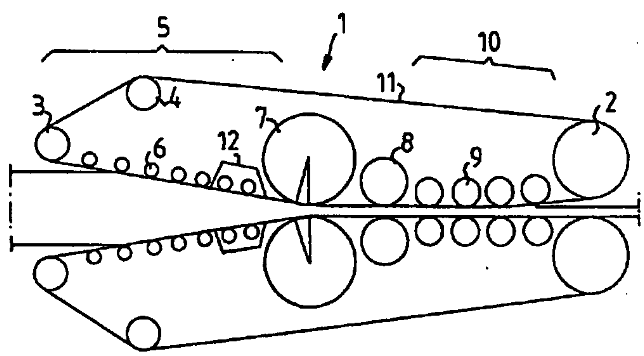

(57) Abstract

A method of continuous manufacture of board of lignocellulosic fiber material where the material is disintegrated to particles and/or fibers, dried, glued and formed to a mat and pressed to a finished board. In a first step the formed mat is heated through by steam and compressed to an at least partially hardened board with substantially uniform density. In a second step the surface layers of the board are compressed to higher density and hardened in a calibration zone to a finished board.

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Method of manufacturing lignocellulosic board

Methods of manufacturing board from raw materials based on lignocellulose are well-known and in practice widely applied. The manufacturing process comprises the following main steps: disintegration of the raw material to particles and/or fibers of suitable size, drying to a definite moisture ratio and glueing the material prior or subsequent to the drying, forming the glued material to a mat, which can be built up of several layers, possibly cold prepressing, preheating, surface bozzle-spraying a.o. and hot-pressing simultaneously with pressure and heat applied in a discontinuous or continuous press to a finished board.

At conventional hot pressing, the pressed material is heated substantially by means of thermal conduction from the adjacent heating plates or steel belts which have a temperature of 150-250°C, depending on the type of product being pressed, the glue used, the desired capacity a.o. The moisture of the material closest to the heat sources is hereby evaporated, whereby as the pressing continues a dry layer develops and a steam front successively moves from each side inward to the board centre. The temperature in this developing layer rises to at least 100°C, which initiates normal glues to cure. When the steam front has arrived at the centre of the board, the temperature there has risen to at least 100°C and the board commences to harden even at the centre, whereafter the pressing can be terminated within a number of seconds. This applies to the use of conventional urea formaldehyde glue (UF) and similar ones, such as melamine-fortified glues (MUF). When other glues with higher curing temperatures are used, a higher temperature and a higher pressure must develop in the board before curing can take place. For conventional hot pressing methods have been developed to control the density profile of the board in the thickness direction. In most cases it is desired to achieve a high density in the surface layers in order to improve the paintability, strength and the like, and a reasonably low

density in the central layer, as low as possible for holding board weight and cost down, and sufficiently high for achieving an acceptable internal bond strength and the like. At the manufacture of particle board, more finely disintegrated particles with a slightly higher moisture in the surface layers often have been used a.o. in order to achieve a higher density in the surface layers of the board. At the manufacture of MDF (Medium Density Fiberboard), which have a homogeneous material structure, methods have been developed by means of a controlled distance between the heat sources to approach the final position successively in a predetermined way as the steam front moves inward to the centre. See, for example, the patent SE 469270 for continuous press and pat. appln, SE 93 00772-2 for a single opening discontinuous press. These methods, which were developed for MDF, are now at least partly also used for other types of board.

In order to achieve the desired density profile, a press must be capable to apply high surface pressure at high temperature. This is per se no problem for a discontinuous press which, however, has other disadvantages, such as a.o.inferior thickness tolerances. For continuous presses the required high surface pressure and simultaneously high temperature have implied expensive precision solutions for the roller table between steel belt and underlying heating plate. The method of supplying heat to the board via thermal conduction further implies, that the heating takes a relatively long time, which results in great press lengths (large press surfaces).Presses up to about 40 m length have been delivered. Furthermore, with a continuous press it is practically not possible to make the heating plates of the press sufficiently flexible and, therefore, the density profile cannot be formed with as great a freedom as in the case of discontinuous pressing.

The continuous presses of to-day, besides, are restricted as regards temperature (because of the lubricating oil in the roller table), which means that not all types of board can be pressed.

Another method of board manufacture, which is based on the supply of steam in between the heating plates in a discontinuous press, also has found limited use. The material there is heated within seconds at the supply of steam and, therefore, the heating time can be shortened radically. Moreover, after the supply of steam the resistance of the material against compression reduces considerably. This is a positive feature implying that the press could be designed with less press power and a much shorter length (smaller press surface). For achieving a desired density profile of a board manufactured according to this method, however, conventional pressing technique with high surface pressure and thermal conduction from conventional heating plates at the beginning of the press cycle had to be applied, whereby a surface layer with high density was obtained after a long heating time. First thereafter steam could be injected for heating the central part of the board. This has given rise to problems, because steam has to be blown through the newly formed surface layer with high density, and because the pressing time during the period of high pressures and thermal conduction has been extended considerably. As a consequence thereof, a steam press operating according to this concept has a much lower capacity, alternatively a larger press surface, and requires a higher press power than would be required if a uniform density had been tried to attain.

At all manufacturing methods referred to above, a soft surface layer is obtained, which has lower strength, unacceptable paintability a.o., which implies that this layer must be ground off. The resulting material loss is 5-15%, depending on board type, thickness a.o.

One object of the present invention is to offer a method of continuous pressing of board of lignocellulosic material, which method makes it possible to make use of the advantages of steam heating , implying that the equipment then can be designed with considerably smaller press surface and with lower press power, i.e. less expensive, and, besides, without heating

plates, whereby the present precision solutions with roller tables are eliminated, which renders the equipment still less expensive, and yet have the possibility of achieving desired density profiles.

Another object of the invention is to make the manufacturing process so flexible that different density profiles and surface properties can be formed in new ways and thereby new fields of application for board can be created.

According to the invention, the pressing is carried out in two steps, in such a manner, that in the first step the board is given a uniform (straight) density profile, and in a second step the density of the surface layers is formed, and that steam is used for heating the board in the first step.

In the first step the mat is compressed to moderate density, whereafter steam is supplied, and thereafter the mat is compressed further to the final density for step 1. Thereafter the board is allowed to harden entirely or partially in a holding section.

In the second step the surface layers are affected substantially by heat and pressure, so that the surface material is softened for a period sufficiently long to obtain surface layers with the desired depth and increased density. The treatment in step 2 can be prepared in several ways and with different objects, depending on the final product desired to be obtained. At an alternative embodiment, the fibers originally have been glued with a glue having such a composition, that in step 1 a bond sufficient to produce a board is obtained, and that the final bonding in the surface layers takes place by the heat and pressure treatment in step 2.

At another alternative embodiment the board was formed as a three-layer board, where the central layer has cured during step 1, but where the glue of the surface layer has not yet cured completely.

At a third alternative embodiment the softening of the surface layers in step 2 takes place by applying a liquid, which can contain glue, surface-sealing agent or other chemicals.

At a fourth alternative embodiment the surface layers on the manufactured board are treated wirh gas or steam by means of a controlled gas or steam amount supplied to each surface.

At a further alternative embodiment the softening in step 2 can be carried out by a chemical having a known softening effect.

The method according to the present invention shows the essential difference, compared with conventional board pressing, that a board with desired central density can be subjected to final pressing, and that re-heating of the surface layers softening them so as to make them re-formable does not deteriorate the already hardened central layer. The process hereby obtained renders it possible to press at a lower pressure and for a shorter time (smaller total press surface).

At a preferred embodiment of the process according to step 1 the mat coming from the forming station (which mat can be unpressed, or cold-pressed in a separate belt pre-press, if it is desired both to better manage the belt transitions and to more easily indicate possible metal) is first compressed, in a press inlet of a roller press provided with wires, to the density 150-500 kg/m^3 whereafter steam is supplied through the surfaces via steam chest(s) and/or steam roller(s). The mat is thereafter successively compressed further to slightly below final thickness by means of pairs of rolls whereafter the mat is allowed to expand and harden in a holding section (calibration zone) with rolls. The roller press should be heated so that condensation is avoided when steam is supplied. By said light over-compression to below final thickness, the surface pressures required in the holding section are very low and, therefore, the press can be designed as a light-weight construction. Contrary to all previously known presses for the manufacture of lignocellulosic board it was found possible from a process-technical aspect to obtain board with good properties even at high densities, in spite of the fact that in the holding

section in step 1 no heating plates are used.

At a continuous roller press steam is supplied continuously, and a small surplus of steam exceeding the amount required for heating the mat is added, whereby it is ensured that all air included in the mat is pressed rearward in the inlet, which further ensures that all parts of the mat are heated.

At an alternative embodiment a steam chest and/or suction box can be arranged in the holding section for controlling board temperature, moisture and included pressure.

The board thus pressed in step 1 can proceed to intermediate storage when the board is intended to be made-up (surface treated) lateron in step 2, or continue directly to step 2 for surface treatment.

At a preferred embodiment of the process according to step 2, the board is passed through one or several pairs of hot rolls, whereby the surface layer is heated successively and is compressed further due to the temperature and linear load of the rolls. Depending on the intended field of application for the board, the treatment can consist of a few press nips at moderate pressures in order to create only a thin "skin" for improved paintability a.o., to a plurality of press nips with higher linear loads in cases when a thicker surface layer with increased surface density is desired, i.e. for products similar to conventional board. By this treatment the aforementioned grinding can often be reduced or eliminated, which results in a substantial saving. It is important for the process in step 2 that the rolling temperature can be controlled accurately in a known manner, preferably by hot oil heating.

In order to improve desired effects on the surface layer, the surface layers, as mentioned before, can have been prepared before the roll inlet.

At an alternative embodiment of step 2 the press according to step 2 is provided with a steel belt alternatively wire. Hereby the heat losses from the board between the roll pairs are reduced and thereby the desired effect is achieved more easily, alternatively a smaller number of roll nips is required.

The invention is described in greater detail by way of a preferred embodiment where

Fig. 1 shows a heated belt press for step 1 of the invention, where the belts are perforated belts or wires, and the press is provided with equipment for steam supply,

Fig. 2 shows a heated belt press for step 2 of the invention, where the belts are solid steel belts, and preparation can take place before the inlet in the belt press,

Figs. 3 and 4 show density profiles of board manufactured according to step 1,

Fig. 5 shows density profiles of a board manufactured according to steps 1 and 2.

Fig. 1 shows the embodiment in step 1 by a lateral view of a belt press 1, which in known manner is provided with drive rollers 2, stretching rollers 3, guide rollers 4 and an adjustable inlet portion 5 with inlet roller 6, steam roller 7, compression roller 8 and rollers 9 in a holding section 10 and surrounding wire 11, alternatively perforated steel belt with wire. In the inlet portion 5 the mat is compressed to a predetermined density in the range 150-500 kg/m^3, preferably 250-400 kg/m^3 whereafter at the passage past the steam roller 7 steam of 1-6 bar is injected in a sector in contact with the wire in an amount sufficient for heating the mat all through to 100^{o}C and push out all included air. The compression resistance of the mat is hereby reduced significantly, and compression in the compression roller 8 and holding section 10 can be continued with very small forces. In the holding section 10 the glue cures, and a board with a uniform density profile with density 150-900 kg/m^3, preferably 500-700 kg/m^3, is obtained.
At the manufacture of thin board a higher density of the magnitude 800-900 kg/m^{3}is used.

As an alternative or compliment to the steam roller 7, a conventional suction box 12 can be used.

In a similar way a conventional steam chest and a vacuum box can be used in the holding section (not shown in the Figure), in order by supply of steam at controlled pressure to ensure a sufficiently high temperature during the hardening of the board (depending on board type a.o.) and, respectively, for applying a vacuum in order to control residue moisture and to make it possible to deflash excess steam at the outlet end of the holding section.

Fig. 2 shows the embodiment in step 2 with a belt press 20 with drive roller 13, stretch and guide roller 14, conducting roller 15, compression roller 15 and rollers 17 in a calibration zone 18, and steel belt 19. The board manufactured in step 1 is fed in from the left in the Figure through a preparation zone 21 where (if required, see above) a measure suitable for the intended result is taken, whereafter the board is inserted into the inlet of the belt press. The position of the conducting roller 15 is adjustable, so that the time of contact between the board and hot steel belt is adjustable before the main compression takes place in roller 16, whereby the surface layer of the board is additionally heated. The pressing force at the compression of the surface layers in roller 16 is hereby reduced. Continued compression of the surface layers takes place successively from one nip to another in the calibration zone 18.

Due to the fact that at the treatment a temperature of at least 50 degrees above the glass transformation temperature is achieved in the surface layer, the material can be easily compressed.

EXAMPLE

In Fig. 3 a fiberboard with uniform, very low density (average density 174 kg/m^3) is shown, which was manufactured by the method according to step 1. The density at steam supply is 200 kg/m^3.

In Fig. 4 a fiberboard with average density 677 kg/m^3 is shown, which also was manufactured by the method according to step 1. The density at steam supply is 300 kg/m^3.

In both cases an internal bond strength was obtained which corresponds to conventional board with same densities and good surfaces with little pre-hardening.

Fig. 5 shows a fiberboard, which was manufactured according to step 1 with uniform density similar to Fig. 4 and thereafter was after-pressed in step 2 in a roller press with steel belt, with the following data:
Steam was injected into the board surfaces prior to the roller pressing. steel belt temperature 270^{o}C, maximum pressure in compression roller 60 bar.

The embodiment is not restricted to the ones described above, but can be varied within the scope of the invention idea.

Claims

1. A method of continuous manufacture of board from lignocellulosic fiber material, where the material is disintegrated to particles and/or fibers, dried, glued and formed to a mat and pressed to a finished board, c h a r a c t e r i z e s i n that the formed mat in a first step is heated through with steam and compressed to an at least partially hardened board with substantially uniform density, and that thereafter in a second step the surface layers of the board are compressed to a higher density and hardened in a calibration zone to a finished board.

2. A method as defined in claim 1, c h a r a c t e r i z e d i n that the mat in the first step is compressed to below final thickness whereafter it is allowed to expand to final thickness and harden in a calibration zone and maintain this thickness before it is transferred to the second step.

3. A method as defined in claim 1 or 2, c h a r a c t e r i z e d i n that in the first step steam is supplied in such an amount, that air included in the mat is pressed rearward through the mat.

4. A method as defined in any one of the preceding claims, c h a r a c t e r i z e d i n that the board compressed in the first step is intermediately stored before it is moved into the second step.

5. A method as defined in anyone of the claims 1 - 3, c h a r a c t e r i z e d i n that the board compressed in the first step is transferred directly to the second step.

6. A method as defined in any one of the preceding claims, c h a r a c t e r i z e d i n that the fiber material is glued with glue yielding a sufficient bond for producing a board in the first step, but not yielding final bonding in the surface layers before its treatment in the second step.

7. A method as defined in any one of the claims 1 - 5, c h a r a c t e r i z e d i n that the formed mat consists of several layers, and the surface layers are hardened through first in the second step.

8. A method as defined in any one of the claims 1 - 5, c h a r a c t e r i z e d i n that the surface layers of the board manufactured in the first step are softened prior to and/or during the compression in the second step.

9. A method as defined in any one of the preceding claims, c h a r a c t e r i z e d i n that the surface layers of the board in the second step are heated to a temperature of more than 50 degrees above the glass transition temperature of the fiber material during the compression.

10. A method as defined in any one of the preceding claims, c h a r a c t e r i z e d i n that the surface layers of the board manufactured in the first step are coated with a liquid film prior to the compression in the second step.

11. A method as defined in claim 10, c h a r a c t e r i z e d i n that the liquid film contains solved glue substance.

12. A method as defined in claim 10, c h a r a c t e r i z e d i n that the liquid film contains surface-sealing agent.

13. A method as defined in claim 10, c h a r a c t e r i z e d i n that the liquid film contains chemicals with softening effect.

14. A method as defined in any one of the preceding claims, c h a r a c t e r i z e d i n that the surface layers on the board manufactured in the first step is pre-prepared with gas or steam prior to the compression in the second step.

15. A method as defined in any one of the preceding claims, c h a r a c t e r i z e d i n that the mat in the first step is compressed to a density of 150-500 kg/m^3, preferably 250-400 kg/m^3, before steam is supplied.

16. A method as defined in any one of the preceding claims, c h a r a c t e r i z e d i n that the mat in the first step is compressed to a final thickness corresponding to a density of 150-900 kg/m^3.

17. A method as defined in any one of the claims 2 - 16, c h a r a c t e r i z e d i n that steam at controlled pressure is supplied also in the calibration zone in the first step.

18. A method as defined in any one of the claims 2 - 17, c h a r a c t e r i z e d i n that vacuum is applied at the end of the calibration zone in the first step.

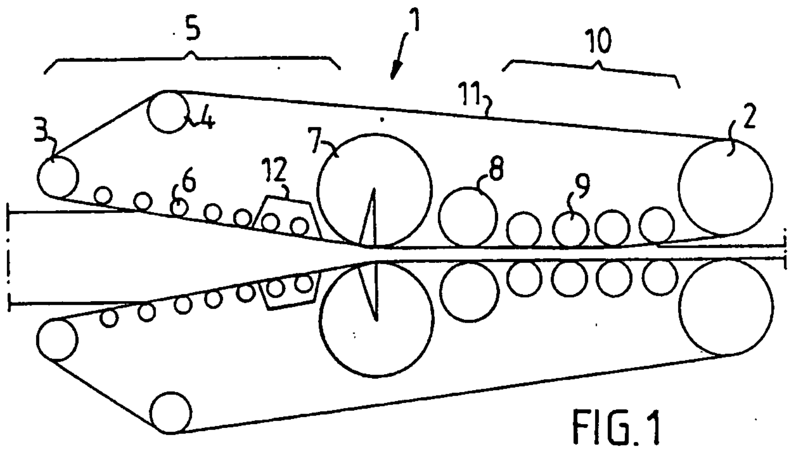


FIG. 1

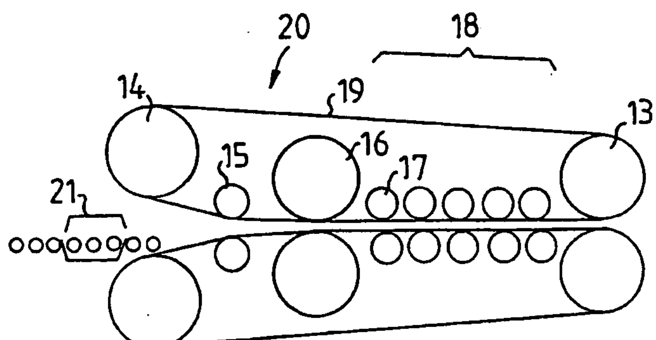
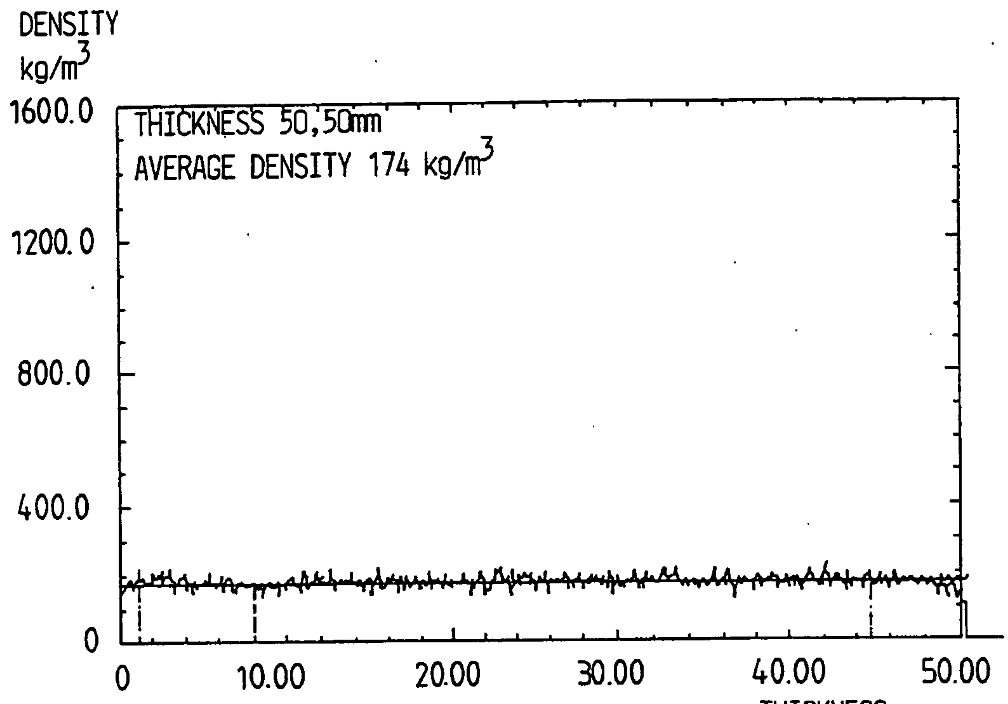


FIG. 2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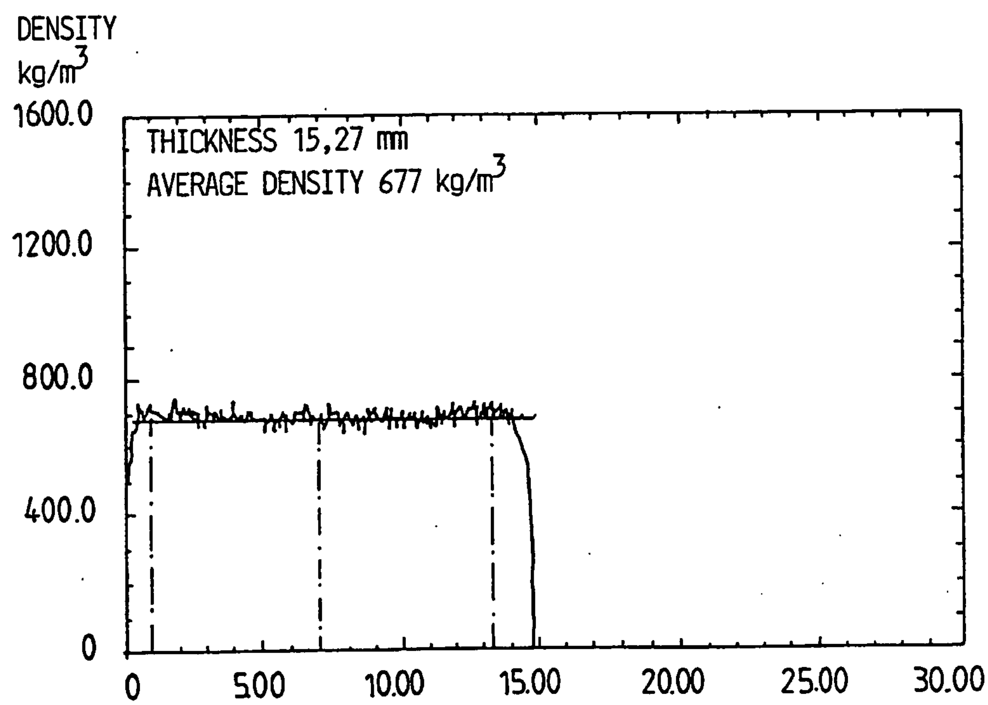
THICKNESS, mm

FIG. 3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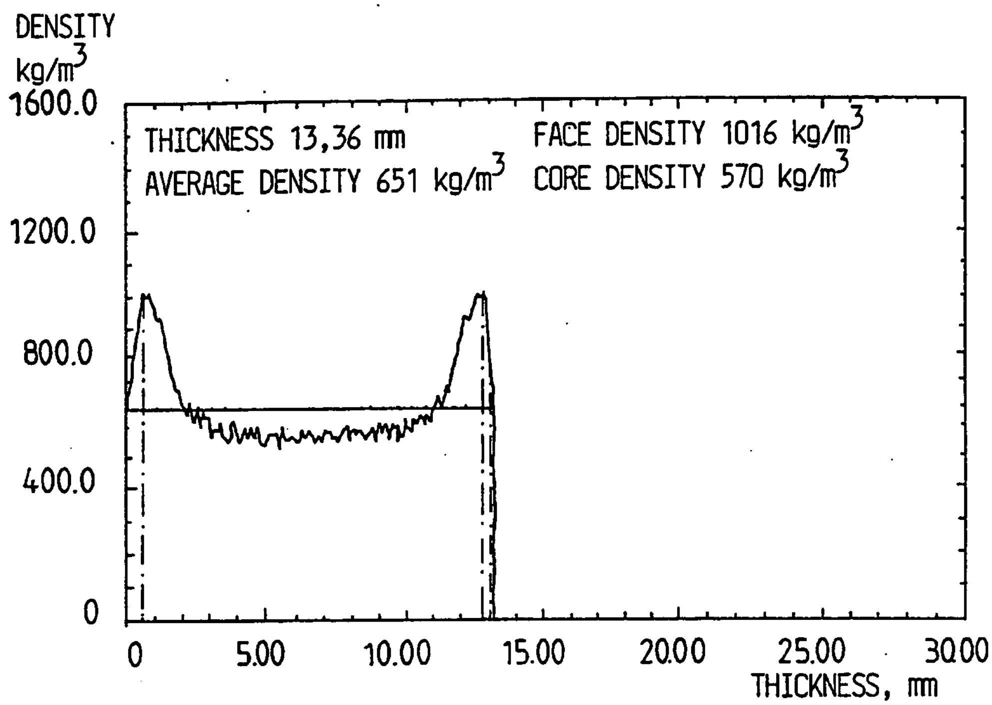
30.00
THICKNESS, mm

FIG.4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FACE DENSITY 1016 kg/m3
CORE DENSITY 570 kg/m3
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5.00
10.00
15.00
20.00
25.00
30.00
THICKNESS, mm

FIG.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 95/00043

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B27N 3/00 // B27N 3/02, 3/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B27N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT
Information on patent family members

01/04/95

International application No.
PCT/SE 95/00043

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A- 2058820	31/05/72	NONE	

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